DISC DRIVE CIRCUIT BOARD EDGE CONNECTOR

by

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Related Applications

This application claims priority of United States provisional patent application no. 60/302,517 filed on July 2, 2001 and titled "CARD EDGE SERIAL ATA INTERFACE."

Field of the Invention

This application relates generally to storage devices and more particularly to a printed circuit board connector for a storage device.

Background of the Invention

Data is transferred between a host computer and a storage device, such as a disc drive, by way of an interface, which typically includes a buffer to facilitate high-speed data transfer between the host computer and the storage device. Data to be written to or read from the storage device is thus passed between the host computer and the storage device interface and between the interface and a read/write channel. Generally, the storage device interface includes hardware and/or software that regulates transmission of data and manages the exchange of data between the storage device and the host computer. A standard committee such as American National Standard Institute (ANSI) oversees the adoption of an interface protocol by which any peripheral device following the common standard can be used interchangeably.

Although various types of storage device interface standards exist, the Advanced Technology Attachment (ATA) interface standard is widely used for interfaces between host computers and storage devices, such as disc drives. The ATA interface is an official ANSI standard designation for the interface between a storage device and a host computer. Generally, the ATA standard specification deals with the power and data signals interface between the motherboard in the host computer and the storage device controller in the storage device.

In connecting a disc drive to one more computers, the ATA interface standard introduces an interconnect specification. A previous ATA standard was known as the parallel ATA (PATA) interconnect specification. Originally introduced in the 1980s, the PATA interconnect specification has been the dominant internal storage interconnect for desktop and mobile computers. It has been used to connect storage devices such as hard drives, digital video disc

drives, and compact disc drives to the motherboard. However, PATA has a number of limitations that are exhausting its ability to continue increasing performance to meet the demands of evolving storage devices and host computers.

The limitations in the PATA interconnect specification have led to the development of a new ATA specification, known as serialized, or serial, ATA. The serialized ATA specification includes detailed geometric dimensions for connections between the storage device and connecting cables or host computers. The specification calls for a device signal plug connector and a device power plug connector, each with different dimensions. The device plug connectors have contact pads formed on tabs extending from the device plug connectors. The device plug connectors further include leads extending from the contact pads to the circuit board of the storage device. The device plug connectors are often mounted onto storage device circuit boards and the leads from the device plug connectors are soldered onto electrically conductive elements of the circuit boards. Accordingly, the device plug connectors have incorporated contact pads and leads.

The contact pads and leads increase the manufacturing costs of the device plug connectors. Additionally, the procedure of connecting each lead of the device plug connectors to the circuit board increases manufacturing costs. For example, the circuit board and the connectors must be handled delicately during manufacturing to maintain the position of the solder contacts until they are soldered together. Accordingly there is a need for an improved circuit board edge connector that is compatible with standard specifications, such as the serialized ATA standards.

Summary of the Invention

Against this backdrop the present invention has been developed. An embodiment of the present invention may be summarized as a connector for connecting a disc drive circuit board to a device outside the disc drive. The connector includes a circuit board tab forming part of the circuit board and extending from it. Contact pads are formed on the circuit board tab. A housing attached to the circuit board includes a housing tab extending from the housing, the housing tab being substantially parallel and adjacent to the circuit board tab, such that the circuit board tab and the housing tab together form a connecting tab.

Alternatively, an embodiment of the present invention may be summarized as a disc drive including a rotatable disc, a disc drive circuit board, and a connector for connecting the circuit

board to a device outside the disc drive. The connector includes a substantially rectangular circuit board tab forming part of the circuit board and extending from it. Contact pads are formed on the circuit board tab. The connector also includes a housing attached to the circuit board that includes a housing tab extending from the housing in the first direction, the housing tab being substantially parallel to and abutting the circuit board tab, such that the housing tab and the circuit board tab together form a connecting tab.

Stated still another way, an embodiment of the present invention is a disc drive having a disc mounted for rotation on a spindle motor. The disc drive includes a printed circuit board and means for electrically and mechanically connecting the circuit board to a device outside the disc drive.

These and various other features as well as advantages which characterize the present invention will be apparent from a reading of the following detailed description and a review of the associated drawings.

Brief Description of the Drawings

FIG. 1 is a plan view of a disc drive incorporating an embodiment of the present invention showing the primary internal components.

FIG. 2 is an exploded perspective view of a connector in accordance with an embodiment of the present invention.

FIG. 3 is a perspective view of the connector of FIG. 2.

FIG. 4 is a partially exploded perspective view of an interface including the connector of FIG. 3 and further including receptacle connectors.

FIG. 5 is an exploded perspective view of a connector in accordance with an alternative embodiment of the present invention.

FIG. 6 is an exploded perspective view of a connector in accordance with an alternative embodiment of the present invention.

FIG. 7 is a perspective view of the connector of FIG. 6.

Detailed Description

A disc drive **100** constructed in accordance with a preferred embodiment of the present invention is shown in FIG. **1**. The disc drive **100** includes a base **102** to which various components of the disc drive **100** are mounted. A top cover **104**, shown partially cut away, cooperates with the base **102** to form an internal, sealed environment for the disc drive in a conventional manner. The components include a spindle motor **106**, which rotates one or more discs **108** at a constant high speed. Information is written to and read from tracks on the discs **108** through the use of an actuator assembly **110**, which rotates during a seek operation about a bearing shaft assembly **112** positioned adjacent the discs **108**. The actuator assembly **110** includes a plurality of actuator arms **114**, which extend towards the discs **108**, with one or more flexures **116** extending from each of the actuator arms **114**. Mounted at the distal end of each of the flexures **116** is a head **118**, which includes an air bearing slider enabling the head **118** to fly in close proximity above the corresponding surface of the associated disc **108**.

During a seek operation, the track position of the heads **118** is controlled through the use of a voice coil motor **124**, which typically includes a coil **126** attached to the actuator assembly **110**, as well as one or more permanent magnets **128**, which establish a magnetic field in which the coil **126** is immersed. The controlled application of current to the coil **126** causes magnetic interaction between the permanent magnets **128** and the coil **126** so that the coil **126** moves in accordance with the well-known Lorentz relationship. As the coil **126** moves, the actuator assembly **110** pivots about the bearing shaft assembly **112**, and the heads **118** are caused to move across the surfaces of the discs **108**.

A flex assembly **130** provides the requisite electrical connection paths for the actuator assembly **110** while allowing pivotal movement of the actuator assembly **110** during operation. The flex assembly includes a flex assembly circuit board **132** to which head wires (not shown) are connected; the head wires being routed along the actuator arms **114** and the flexures **116** to the heads **118**. The flex assembly circuit board **132** typically includes circuitry for controlling the write currents applied to the heads **118** during a write operation and a preamplifier for amplifying read signals generated by the heads **118** during a read operation. The flex assembly terminates at a flex bracket **134** for communication through the base deck **102** to a disc drive printed circuit board (see FIGS. **2-7**) mounted to the bottom side of the disc drive **100**.

FIGS. **2-3** depict a device plug connector **210** for connecting a disc drive printed circuit board **212** to a device outside the disc drive **100**. The connector **210** includes a first circuit board tab or power tab **220** that is an integral part of the circuit board **212**, that is preferably substantially rectangular in shape, and that extends from the circuit board **212** in a first direction **222**. The first circuit board tab **220** preferably includes a first major surface **224** (see FIG. **6**) and an opposing second major surface **226**. The first major surface **224** (see FIG. **6**) and the second major surface **226** are joined by a first edge **230** extending in the first direction **222** and an opposing second edge **232** also extending in the first direction **222**. A third edge **234** is distal from the body of the circuit board **212** and extends from the terminus of the second edge **232** to the terminus of the first edge **234** to form the terminus of the first circuit board tab **220**. The third edge **234** is preferably beveled or rounded. The first circuit board tab **220** further includes electrically conductive contact pads **236** for supplying power to the disc drive via the circuit board **212**.

Connector **210** preferably also includes a second circuit board tab or signal tab **240** that is preferably substantially rectangular in shape and extends from the circuit board **212** in the first direction **222**. The second circuit board tab **240** preferably includes a first major surface **244** (see FIG. **6**) and an opposing second major surface **246** that are both substantially flat and rectangular. The first major surface **244** (see FIG. **6**) and the second major surface **246** are joined by a first edge **250** extending in the first direction and an opposing second edge **252** also extending in the first direction. The first edge **250** of the second circuit board tab **240** and the first edge **230** of the first circuit board tab **220** face toward each other while the second edge **252** of the second circuit board tab **240** and the second edge **232** of the first circuit board tab **220** face away from each other. A third edge **254** is distal from the body of the circuit board **212** and extends from the terminus of the second edge **252** to the terminus of the first edge **250** to form the terminus of the second circuit board tab **240**. The third edge **254** is preferably beveled or rounded. The second circuit board tab **240** further includes electrically conductive contact pads **256** for conducting signals between outside devices and the disc drive **100** via the circuit board **212**.

The circuit board **212** defines a gap **260** between the first edge **230** of the first circuit board tab **220** and the first edge **250** of the second circuit board tab **240**. The circuit board **212** also defines a gap **262** adjacent the second edge **232** of the first circuit board tab **220** and a gap **264** adjacent the second edge **252** of the second circuit board tab **240**.

Referring still to FIGS. **2-3**, the connector **210** also includes a housing **270**. The housing **270** preferably includes a substantially rectangular rear wall **272** defining a first slot **274** that receives the first circuit board tab **220** so that the first circuit board tab **220** extends through the rear wall **272**. A second slot **276** in the rear wall **272** receives the second circuit board tab **240** so that the second circuit board tab **240** also extends through the rear wall **272**. Preferably, the first slot **274** and the second slot **276** are both substantially rectangular windows, meaning that the rear wall **272** surrounds the circuit board tabs **220**, **240** as shown to provide stability to the connector **210**. However, one or both of the slots **274**, **276** may be partially or fully opened on at least one side.

The housing **270** further includes a first housing tab **280** that is preferably substantially rectangular in shape and extends from the rear wall **272** along the first slot **274** in the first direction **222**. The first housing tab **280** includes a first major surface **284** facing toward and preferably abutting the first major surface **224** (see FIG. **6**) of first circuit board tab **220**. First housing tab **280** also includes a second major surface **286** (see FIG. **6**) that is opposite the first major surface **284**. Preferably, the first major surface **284** and the second major surface **286** are both substantially flat and rectangular. The first major surface **284** and the second major surface **286** are joined by a first edge **290** extending in the first direction **222** and an opposing second edge **292** also extending in the first direction **222**. The first edge **290** of the first housing tab **280** and the first edge **230** of the first circuit board tab **220** are adjacent to each other while the second edge **292** of the first housing tab **280** and the second edge **232** of the first circuit board tab **220** are adjacent to each other. A third edge **294** of the first housing tab **280** is distal from the rear wall **272** of the housing **270** and extends from the terminus of the second edge **292** to the terminus of the first edge **290** to form the terminus of the first housing tab **280**. The third edge **294** is preferably beveled or rounded. The third edge **294** of the first housing tab **280** is preferably adjacent the third edge **234** of the first circuit board tab **220**.

The housing **270** preferably also includes a first keying protrusion **298** that extends in the first direction **222** from the rear wall **272** and from the first edge **290** of the first housing tab **280** in a direction normal to the first housing tab **280**. Thus, the first keying protrusion **298** and the first housing tab **280** together form an L-shaped protrusion from the rear wall **272** of the housing **270**. The first circuit board tab **220** extends from the first keying protrusion **298** along the first housing tab **280** so that the first circuit board tab **220** and the first housing tab **280** together form

a first connecting tab **299** (FIG. **3**). The first housing tab **280** preferably defines locking recesses **296** in the second major surface **286** (see FIG. **6**). The locking recesses **296** may extend completely through the first housing tab **280** or they may only extend part way through the first housing tab **280** depending on the thickness of the first housing tab **280**. The locking recesses **296** receive locking protrusions from a mating receptacle connector as will be described in more detail below.

Still referring to FIGS. **2-3**, the housing **270** preferably also includes a second housing tab **320** that is preferably substantially rectangular in shape and extends from the rear wall **272** along the second slot **276** in the first direction **222**. The second housing tab **320** preferably includes a first major surface **324** facing toward and preferably abutting the first major surface **244** (see FIG. **6**) of the second circuit board tab **240**. The second housing tab **320** preferably also includes a second major surface **326** (see FIG. **6**) that is opposite the first major surface **324**. Preferably, the first major surface **324** and the second major surface **326** (see FIG. **6**) are both substantially flat and rectangular. The first major surface **324** and the second major surface **326** (see FIG. **6**) are joined by a first edge **330** extending in the first direction **222** and an opposing second edge **332** also extending in the first direction **222**. The first edge **330** of the second housing tab **320** and the first edge **250** of the second circuit board tab **240** are adjacent to each other while the second edge **332** of the second housing tab **320** and the second edge **252** of the second circuit board tab **240** are adjacent to each other. A third edge **334** of the second housing tab **320** is distal from the rear wall **272** of the housing **270** and extends from the terminus of the second edge **332** to the terminus of the first edge **330** to form the terminus of the second housing tab **320**. The third edge **334** is preferably beveled or rounded. The third edge **334** is adjacent the third edge **254** of the second circuit board tab **240**.

The housing **270** preferably further includes a second keying protrusion **338** that extends in the first direction **222** from the rear wall **272**. The second keying protrusion **338** also extends from the first edge **330** of the second housing tab **320** in a direction normal to the second housing tab **320** so that the second keying protrusion **338** and the second housing tab **320** together form an L-shaped protrusion from the rear wall **272** of the housing **270**. The second circuit board tab **240** extends from the second keying protrusion **338** along the second housing tab **320** so that the second circuit board tab **240** and the second housing tab **320** together form a second connecting tab **339** (FIG. 3). The second housing tab **320** preferably defines a locking recess **336** in the

second major surface **326** (see FIG. **6**). The locking recess **336** may extend through the second housing tab **320** or it may extend only partially through the second housing tab **320**. The locking recess **336** receives locking protrusions from a mating receptacle connector as will be described in more detail below.

A first generally U-shaped section **340** extends in the first direction **222** from the end of the rear wall **272** that is proximal the first housing tab **280**. The first U-shaped section **340** defines a first channel **342** that opens toward the first housing tab **280**. The first U-shaped section **340** terminates in a U-shaped edge **343** that is preferably beveled or rounded inwardly toward the first channel **342**. A second generally U-shaped section **344** extends in the first direction **222** from the end of the rear wall **272** that is proximal the second housing tab **320**. The second U-shaped section **344** defines a second channel **346** that opens toward the second housing tab **320**. The second U-shaped section **344** also terminates in a generally U-shaped edge **347** that is preferably beveled or rounded inwardly toward the second channel **346**.

The housing **270** shown in FIGS. **2-3** further includes snap levers **350** extending from the rear wall **272** in a second direction **351** opposite from the first direction **222** along the circuit board **212**. Each snap lever **350** includes a protrusion **352** that engages a mating recess or hole **354** in the circuit board **212**. The protrusions **352** and the recesses **354** are preferably circular, but they can be any of various shapes so long as the protrusions **352** can securely engage the recesses **354**.

While the connector **210** preferably includes two connecting tabs **299**, **339** (FIG. **3**) as described above, the present invention also encompasses the use of only one connecting tab or more than two connecting tabs. Moreover, while in a preferred embodiment the connector **210** complies with the dimensional requirements for the serialized ATA standard, which are known to those skilled in the art, the dimensions of the connector **210** may vary depending on the specific situation.

Referring now to FIG. **4**, an interface **356** includes the connector **210** and further includes a first receptacle connector **360** that is electrically connected to a device outside the disc drive **100**, such as a host computer. The first receptacle connector **360** includes a housing **362** that defines a mating recess **364**, which preferably includes a tab slot **366** that receives the first connecting tab **299** (see FIG. **3**) and a keying slot **368** that extends normal to the tab slot **366** to receive the first keying protrusion **298**. Thus, the mating recess **364** forms an L-shaped recess to

mate with the L-shaped protrusion formed by the first keying protrusion **298** and the first connecting tab **299** (see FIG. **3**). The first receptacle connector **360** preferably also includes locking protrusions (not shown) that extend into the tab slot **366** to engage the locking recesses **296** (see FIG. **6**) of the first housing tab **280**. The first receptacle connector **360** preferably also includes a protrusion or guide **370** extending from a side of the housing **362** opposite the keying slot **368**. The guide **370** preferably includes beveled or rounded surfaces and fits within the first channel **342** (see FIG. **3**).

The interface **356** further includes a second receptacle connector **380** that is electrically connected to a device outside the disc drive **100**, such as a host computer. The second receptacle connector **380** includes a housing **382** that defines a mating recess **384**. The mating recess **384** includes a tab slot **386** that receives the second connecting tab **339** and a keying slot **388** that extends normal to the tab slot **386** to receive the second keying protrusion **338**. Thus, the mating recess **384** is an L-shaped recess to mate with the L-shaped protrusion formed by the second keying protrusion **338** and the second connecting tab **339** (see FIG. **3**). The second receptacle connector **380** preferably also includes a locking protrusion (not shown) that extends into the tab slot **386** to engage the locking recess **336** (see FIG. **6**) of the second housing tab **320**. The second receptacle connector **380** also includes a protrusion or guide **390** extending from a side of the housing **382** distal from the keying slot **388**. The guide **390** preferably includes beveled or rounded surfaces and fits within the second channel **346**.

The receptacle connectors **360, 380** can be constructed according to known manufacturing methods or standard receptacle connectors can be used. The receptacle connectors can be separate connectors as shown in FIG. **4**, or they can be combined to form one integral receptacle connector that mates with both connecting tabs. Additionally, the receptacle connectors can be remotely connected to an external device, such as by cables, or they can be host receptacle connectors that are mounted directly to the external device (e.g., mounted to the back plane of a drive bay). Also, the present invention can be used in an embodiment that includes only one receptacle connector or that includes more than two receptacle connectors.

If the host receptacle connectors 360, 380 are mounted on the back plane of a drive bay, several features of the housing 270 can be omitted without adversely affecting the performance of the connector 210. For example, the locking recesses 296, 336 could be omitted because the drive will remain connected to the back plane receptacle connectors even without such features.

Also, the keying protrusions 298, 338 could be omitted because the drive could be properly oriented with respect to the drive bay without such features.

If the drive 100 were to be used only with receptacle connectors connected to cables, then the generally U-shaped sections 340, 344 could be omitted because a user could visually guide the connector 210 into engagement with the corresponding receptacle connectors 360, 380. However, in a backplane environment, the U-shaped sections 340, 344 aid in blindly mating the connector 210 into engagement with the corresponding receptacle connectors 360, 380. Nevertheless, the embodiment described above and shown in the figures is preferred because it provides optimal performance whether the drive 100 is used in a backplane environment or a cable connection environment.

In a preferred embodiment of the present invention, the interface **356** complies with the dimensional requirements of the serialized ATA standard, which are known to those skilled in the art. For example, in a preferred embodiment the first connecting tab **299** has a thickness (i.e., a distance between the second major surface **226** of the first circuit board tab **220** and the second major surface **286** of the first housing tab **280**) of about 1.23 mm. If the circuit board **212** has a particular thickness, then the thickness of the first housing tab **280** can be chosen so that the first circuit board tab **220** and the first housing tab **280** together produce the desired thickness of the resulting connecting tab **299**. The tab slot **366** of the corresponding first receptacle connector **360** preferably has a thickness slightly larger than the thickness of the connecting tab **299**. In a preferred embodiment, the tab slot **366** has a thickness of about 1.4 mm. The second connecting tab **339** also has a thickness of about 1.23 mm and the tab slot of the second receptacle connector **380** has a thickness of about 1.4 mm.

In making the connector **210**, the circuit board **212** can be manufactured according to well-known methods. During such manufacturing, the features discussed herein, such as tabs, gaps, recesses, and contact pads are preferably formed in the circuit board **212** as an integral part of the normal manufacturing processes. The housing **270** is preferably formed out of a stiff and inexpensive material. In a preferred embodiment, the housing **270** is molded from a fiber-reinforced thermoplastic, such as a fiberglass-reinforced thermoplastic. The manufacturing process for the connector **210** is simplified because contact pads or other electrical leads need not be formed in the housing **270**.

Referring now to FIGS. **2-4**, the housing **270** is secured to the circuit board **212** by sliding the housing **270** onto the circuit board in a direction opposite to the first direction **222** so that the first circuit board tab **220** and the second circuit board tab **240** slide through the first slot **274** and the second slot **276**, respectively. The beveled third edges **234**, **254** of the circuit board tabs **220**, **240**, respectively, aid in guiding the circuit board tabs **220**, **240** into the slots **274**, **276**, respectively. Once the housing **270** is properly positioned on the circuit board **212**, the protrusions **352** of the snap levers **350** snap into engagement with the corresponding recesses **354** in the circuit board **212** to secure the housing **270** to the circuit board **212**. This easy attachment of the housing **270** to the circuit board **212** distinguishes prior ATA connector housings, which require that solder contacts from the housing be joined with solder contacts from the circuit board during manufacturing.

With the housing **270** secured to the circuit board **212**, receptacle connectors **360**, **380** can easily be electrically and mechanically attached to the circuit board **212** to form interface **356**. The first receptacle connector **360** slides into engagement by sliding the guide **370** within the first channel **342** so that the first connecting tab **299** and the first keying protrusion **298** slide into the tab slot **366** and the keying slot **368**, respectively, of the mating recess **364**. The beveled third edge **234** of the first circuit board tab **220**, the beveled third edge **294** of the first housing tab **280**, the beveled entry of the mating recess **364**, the beveled surfaces of the guide **370**, and the beveled edges of the first U-shaped section **340** all aid in guiding the first receptacle connector **360** into a proper mating relationship with the first circuit board tab **220** and the housing **270**. Once the first receptacle connector **360** is properly positioned with respect to the first circuit board tab **220** and the housing **270**, projections from the first receptacle connector **360** engage the locking recesses **296** formed in the first housing tab **280** to secure the receptacle connector **360** to the housing **270** and thus to the circuit board **212**. The contact pads **236** on the first circuit board tab **220** contact electrically conductive elements of the first receptacle connector **360**, thereby electrically connecting the contact pads **236**, and thus the disc drive **100**, to an external device such as a host computer.

The second receptacle connector **380** similarly slides into engagement by sliding the guide **390** within the second channel **346** so that the second connecting tab **339** and the second keying protrusion **338** slide into the tab slot **386** and the keying slot **388**, respectively, of the mating recess **384**. The beveled third edge **254** of the second circuit board tab **240**, the beveled

third edge **334** of the second housing tab **320**, the beveled entry of the mating recess **384**, the beveled surfaces of the guide **390**, and the beveled edges of the second U-shaped section **344** all aid in guiding the second receptacle connector **380** into a proper mating relationship with the second circuit board tab **240** and the housing **270**. Once the second receptacle connector **380** is properly positioned with respect to the second circuit board tab **240** and the housing **270**, a projection from the second receptacle connector **380** engages the locking recess **336** formed in the second housing tab **320** to secure the receptacle connector **380** to the housing **270** and thus to the circuit board **212**. The contact pads **256** on the second circuit board tab **240** contact electrically conductive elements of the second receptacle connector **380**, thereby electrically connecting the contact pads **256**, and thus the disc drive **100**, to an external device such as a host computer.

FIGS. **5-7** depict alternative embodiments of the present invention that are similar to the embodiment of FIGS. **2-4**, except they embody alternative connections between the housing **270** and the circuit board **212**. When referring to FIGS. **5-7**, the same reference numerals will be used for like features, but new reference numerals will be used for the specific features that differ from the embodiment of FIGS. **2-4**. Additionally, only those features that differ from the embodiment of FIGS. **2-4** will be described. Referring now to FIG. **5**, an integral snap lever **410** extends from each of the U-shaped sections **340**, **344** in the second direction **351** (see FIG. **2**). Each snap lever **410** moves in substantially the same plane as the circuit board **212** and includes a protrusion **412** at its terminus that extends away from the housing **270**. The circuit board **212** defines opposing recesses **414** in the edges of the circuit board **212** that face toward the gaps **262**, **264** that are on opposite sides of the circuit board tabs **220**, **240**. Thus, when the housing **270** is properly positioned on the circuit board **212** as described above, the snap levers **410** bias the protrusions **412** into engagement with the recesses **414** to secure the housing **270** to the circuit board **212**.

Referring now to FIGS. **6-7**, the housing **270** includes integral ears **510** that extend from the U-shaped sections **340**, **344** in opposing directions. Each ear **510** preferably defines a hole **512** that is coaxial with a corresponding hole **514** in the circuit board **212**. When the housing **270** is properly positioned on the circuit board **212** as described above, the corresponding holes **512**, **514** align. In a preferred embodiment, the holes **512**, **514** also align with receiving holes (not shown) in the base **102** of disc drive **100**. Fasteners **516**, such as screws, can then be secured through the holes **512**, **514** and into the receiving holes of the base **102** to secure the housing **270**

and the circuit board **212** to the base **102**. Alternatively, the fasteners **516** can extend only through holes **512, 514** and not into the base **102**.

While the embodiments shown preferably comply with the serialized ATA standards, the present invention can also simplify other circuit board edge connectors. The circuit board edge connector **210** can mate with a receptacle **360** or **380** in a manner similar to the way that a separately attached connector would mate with a receptacle. However, this embodiment of the present invention does not require a separately attached connector or housing with electrical connections.

Because the thickness of each housing tab **280** or **320** can be chosen to produce a desired thickness of the resulting connecting tab **299** or **339**, respectively, the connector **210** provides the benefits of prior interface connectors with decreased manufacturing costs. The costs of manufacturing the connector **210** are decreased because the housing **270** need not incorporate contact pads, electrical leads, or solder contacts. Also, no electrical connection between the housing **270** and the circuit board **212** is needed because the contact pads **236** and **256** are formed directly on the circuit board **212**. Thus, the connector **210** need not be handled as delicately as prior connectors during manufacturing. The connector **210** can also be more robust during normal use because an electrical connection between the housing **270** and the circuit board **212** need not be maintained.

An embodiment of the present invention may be summarized as a connector (such as **210**) for connecting a disc drive circuit board (such as **212**) to a device outside the disc drive (such as **100**). The connector (such as **210**) includes a circuit board tab (such as **220** or **240**) forming part of the circuit board (such as **212**) and extending from the circuit board (such as **212**) in a first direction (such as **222**). Contact pads (such as **236** or **256**) are formed on the circuit board tab (such as **220** or **240**). The connector (such as **210**) also includes a housing (such as **270**) attached to the circuit board (such as **212**). The housing (such as **270**) includes a housing tab (such as **280** or **320**) extending from the housing (such as **270**) in the first direction (such as **222**), the housing tab (such as **280** or **320**) being substantially parallel and adjacent to the circuit board tab (such as **220** or **240**), such that the circuit board tab (such as **220** or **240**) and the housing tab (such as **280** or **320**) together form a connecting tab (such as **299** or **339**).

The housing tab (such as **280** or **320**) preferably has a first major surface (such as **284** or **324**) facing toward the circuit board tab (such as **220** or **240**) and a second major surface (such as

286 or 326) facing away from the circuit board tab (such as 220 or 240), and the first major surface (such as 284 or 324) of the housing tab (such as 280 or 320) preferably abuts the circuit board tab (such as 220 or 240). The second major surface (such as 286 or 326) of the housing tab (such as 280 or 320) preferably defines a locking recess (such as 296 or 336) for engaging a projection in a receptacle (such as 360 or 380) connected to the device to secure the connector (such as 210) within the receptacle (such as 360 or 380).

The housing (such as 270) may further include a keying protrusion (such as 298 or 338) extending in the first direction (such as 222) along an edge (such as 290 or 230) of the housing tab (such as 280 or 320) and extending substantially normal to the housing tab (such as 280 or 320). Moreover, the connector may further include a second circuit board tab (such as 220 or 240) forming part of the circuit board (such as 212) and extending from the circuit board (such as 212) in a first direction (such as 222), the second circuit board tab (such as 220 or 240) having contact pads (such as 236 or 256) formed on it. The housing preferably includes a second housing tab (such as 280 or 320) extending from the housing (such as 270) in the first direction (such as 222) and a second keying protrusion (such as 298 or 238) extending in the first direction (such as 222) along an edge (such as 290 or 330) of the second housing tab (such as 280 or 320) and extending substantially normal to the second housing tab (such as 280 or 320), the second housing tab (such as 280 or 320) being substantially parallel and adjacent to the second circuit board tab (such as 220 or 240).

The housing tab (such as 280 or 320) and the keying protrusion (such as 298 or 338) preferably adjoin to form a substantially L-shaped protrusion from the housing (such as 270). Preferably, the circuit board tab (such as 220 or 240) includes a first edge (such as 230 or 250) extending in the first direction (such as 222) and an opposing second edge (such as 232 or 252), wherein the keying protrusion (such as 298 or 338) is adjacent the first edge (such as 230 or 250), and wherein the housing (such as 270) defines a channel (such as 342 or 346) extending in the first direction (such as 222) adjacent the second edge (such as 232 or 252). Also in a preferred embodiment, the circuit board tab (such as 220 or 240) extends through a slot (such as 274 or 276) defined by the housing (such as 270), and the slot (such as 274 or 276) is a window.

In a preferred embodiment, the circuit board tab (such as 220 or 240) includes a first edge (such as 230 or 250) extending in the first direction (such as 222), an opposing second edge (such as 232 or 252) extending in the first direction (such as 222), and a third edge (such as 234 or 254)

joining the first edge (such as **230** or **250**) and the second edge (such as **232** or **252**) to form a terminus of the circuit board tab (such as **220** or **240**), wherein the housing tab (such as **280** or **320**) includes a first edge (such as **290** or **330**) extending in the first direction (such as **222**), an opposing second edge (such as **292** or **332**) extending in the first direction (such as **222**), and a third edge (such as **294** or **334**) joining the first edge (such as **290** or **330**) and the second edge (such as **292** or **332**) to form a terminus of the housing tab (such as **280** or **320**), and wherein the first edge (such as **230** or **250**) of the circuit board tab (such as **220** or **240**) is adjacent the first edge (such as **290** or **330**) of the housing tab (such as **280** or **320**), the second edge (such as **232** or **252**) of the circuit board tab (such as **220** or **240**) is adjacent the second edge (such as **292** or **332**) of the housing tab (such as **280** or **320**), and wherein the third edge (such as **234** or **254**) of the circuit board tab (such as **220** or **240**) is adjacent the third edge (such as **294** or **334**) of the housing tab (such as **280** or **320**).

The housing (such as **270**) may also include an integral protrusion (such as **352** or **412**) that mates with a recess (such as **354** or **414**) in the circuit board (such as **212**) to secure the housing (such as **270**) to the circuit board (such as **212**). Alternatively, the connector (such as **210**) may include a fastener (such as **516**) that extends through the circuit board (such as **212**) and the housing (such as **270**) to secure the housing (such as **270**) to the circuit board (such as **212**).

Stated another way, an embodiment of the present invention may be summarized as a disc drive (such as **100**) including a rotatable disc (such as **108**), a disc drive circuit board (such as **212**), and a connector (such as **210**) for connecting the circuit board (such as **212**) to a device outside the disc drive (such as **100**). The connector (such as **210**) includes a substantially rectangular circuit board tab (such as **220** or **240**) forming part of the circuit board (such as **212**) and extending from the circuit board (such as **212**) in a first direction (such as **222**). Contact pads (such as **236** or **256**) are formed on the circuit board tab (such as **220** or **240**). The connector (such as **210**) also includes a housing (such as **270**) attached to the circuit board (such as **212**). The housing (such as **270**) includes a housing tab (such as **280** or **320**) extending from the housing (such as **270**) in the first direction (such as **222**), the housing tab (such as **280** or **320**) being substantially parallel to and abutting the circuit board tab (such as **220** or **240**), such that the housing tab (such as **280** or **320**) and the circuit board tab (such as **220** or **240**) together form a connecting tab (such as **299** or **339**).

The connector (such as **210**) may further include a second substantially rectangular circuit board tab (such as **220** or **240**) forming part of the circuit board (such as **212**) and extending in the first direction (such as **222**) from the circuit board (such as **212**). Contact pads (such as **236** or **256**) are preferably formed on the second circuit board tab (such as **220** or **240**). Moreover, the housing (such as **270**) preferably further includes a second housing tab (such as **280** or **320**) extending from the housing in the first direction (such as **222**), the second housing tab (such as **280** or **320**) being substantially parallel to and abutting the second circuit board tab (such as **220** or **240**) such that the second housing tab (such as **280** or **320**) and the second circuit board tab (such as **220** or **240**) together form a second connecting tab (such as **299** or **339**). Moreover, the housing (such as **270**) preferably further includes a first keying protrusion (such as **298** or **338**) substantially normal to the first aforesaid housing tab (such as **280** or **320**) extending in the first direction (such as **222**) along an edge (such as **290** or **330**) of the first housing tab (such as **280** or **320**), and wherein the housing (such as **270**). The housing (such as **270**) may further include a second keying protrusion (such as **298** or **338**) substantially normal to the second housing tab (such as **280** or **320**) extending in the first direction (such as **222**) along an edge (such as **290** or **330**) of the second housing tab (such as **280** or **320**).

Stated still another way, an embodiment of the present invention is a disc drive (such as **100**) having a disc (such as **108**) mounted for rotation on a spindle motor (such as **106**). The disc drive includes a printed circuit board (such as **212**) and means (such as **210**) for electrically and mechanically connecting the circuit board (such as **212**) to a device outside the disc drive (such as **100**). Preferably, the means (such as **210**) for connecting includes electrically conductive contact pads (such as **236** or **256**) formed on a tab of the printed circuit board (such as **212**) and means (such as **270**) secured to the printed circuit board (such as **212**) for positioning the contact pads (such as **236** or **256**) within a slot (such as **366** or **386**) of a receptacle connector (such as **360** or **380**).

It will be clear that the present invention is well adapted to attain the ends and advantages mentioned as well as those inherent therein. While embodiments have been described for purposes of this disclosure, various changes and modifications may be made which are well within the scope of the present invention. For example, the keying protrusions may be omitted. Such protrusions are useful for keying (i.e., assuring the correct orientation between mating members), but a skilled user can determine the correct orientation before sliding the receptacle

connectors into a mating position. Numerous other changes may be made which will readily suggest themselves to those skilled in the art and which are encompassed in the scope of the invention disclosed and as defined in the appended claims.